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Larval Development of the Spiny Sand Crab *Lophomastix japonica* (Duruflé, 1889) (Crustacea, Anomura, Albuneidae) under Laboratory Conditions

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With Text-figures 1–9 and Tables 1–3

Abstract The complete larval development of *Lophomastix japonica* (Duruflé, 1889), a spiny sand crab from Hokkaido, northern Japan, is described and illustrated on the basis of laboratory-reared material. The present species passes through three zoeal and one megalopal stages; zoeas moulted to megalopa 30–35 days after hatching, at water temperature of 18°C and salinity of 30 ppt. The carapace of the megalopa exhibits diagnostic features which allow distinction among Japanese albuneid genera. Zoeal characters of *L. japonica* are compared with those of other albuneid species. Morphological remarks on albuneid megalopas are also given.

There are four species of anomuran sand crabs from the coasts of Japan (Miyake, 1978, 1982): *Albunea symnista* (L.), *A. microps* Miers, *Blepharipoda liberata* Shen and *Lophomastix japonica* (Duruflé). Of these, the spiny sand crab *L. japonica* is distributed from northern Japan to Sakhalin. Our knowledge on larvae of these anomurans is still scanty; the only larval description known to Japanese sand crabs is the work by Kurata (1965) which is based on planktonic zoeas from Hokkaido. In addition, Menon (1937) presented a series of zoeas of *A. symnista* reconstructed from planktonic material off Madras, India. No previous larval studies of Japanese albuneids have been based on laboratory-reared material, or dealt with the megalopal stage.

Albuneid megalopas are very similar to adults in general morphology. Recently, Stuck & Truesdale (1986) discussed the development of generic diagnostic characters during post-larval growth in the genus *Lepidopa*, and concluded that the characters were not fully developed until crab 4 stage. Whether their opinion may be applied to the present case is not clear, as will be seen.

The present paper describes the larval stages of the spiny sand crab *L. japonica* observed under laboratory conditions, and gives a comparison of larval stages within the family Albuneidae. Generic diagnostic characters in the megalopal stage of *Lophomastix* are also discussed.

Two ovigerous females of *Lophomastix japonica* were collected from Oshoro Bay, Hokkaido, Japan, on sandy bottoms at a depth of 35 m, on 11 November 1981. Because these females died after collec-

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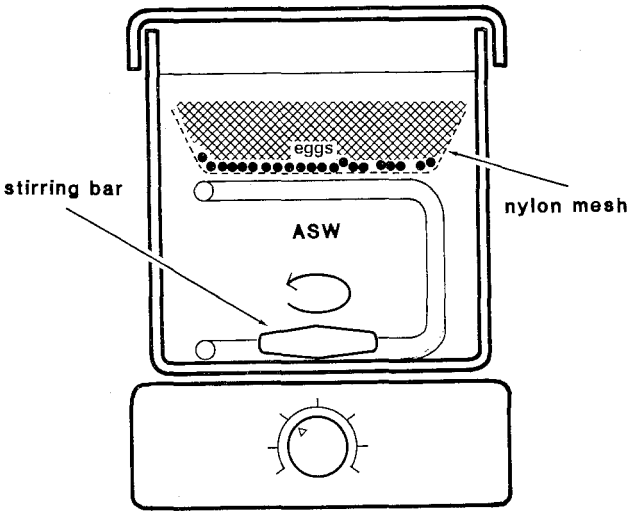

Fig. 1. Artificial incubation system to develop eggs of *Lophomastix japonica* (Duruflé). Eggs are laid upon a nylon mesh in a vessel filled with artificial sea water (ASW), and medium was stirred gently. See text for details.

tion, the eggs were removed and incubated in a static *in vitro* system. Approximately 100 eggs which showed formation of post-naupliar segments and limb buds were detached from the pleopods and disinfected by quickly immersing them into artificial sea water (ASW) (Jamarin®, Jamarin Labo., Osaka, Japan) of 30 ppt salinity, containing 10^{-4}M $KMnO_4$ (modified after Morita, 1974), and then rinsed by ASW for three times; treated eggs were laid upon 110 mm diameter nylon mesh in a glass vessel filled with 800 ml of ASW containing the following antibiotics: 100 units/ml of penicillin G and 0.1 mg/ml of streptomycin sulphate. The ASW was stirred slowly by a magnetic stirrer (see Fig. 1), and the water was changed daily. The temperature was held at 15°C until hatching. The mean size of eggs was 0.93×1.03 mm based on fixed specimens. The first hatching of zoeas occurred on 3 February 1982, and the second on 25 March 1982. Newly-hatched *Artemia* nauplii were given as

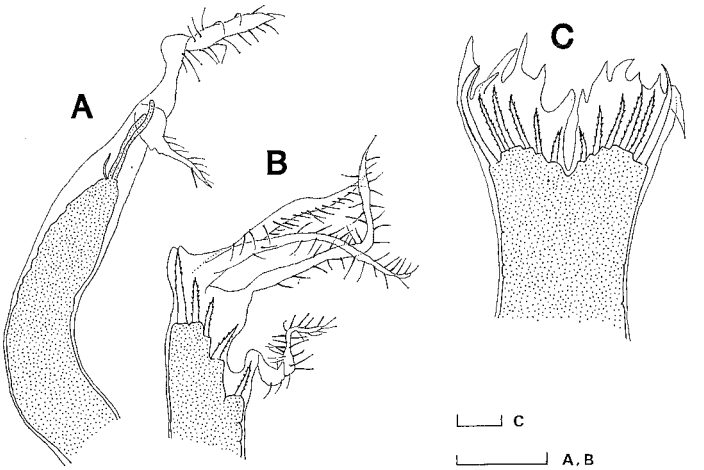

Fig. 2. *Lophomastix japonica* (Duruflé), prezoea: A, antennule; B, antenna; C, telson. Scale bars 0.1 mm.

food, and ASW was used for larval culture at 18°C temperature and 30 ppt salinity. The culture was checked daily for exuviae and dead larvae. The larvae of each stage were fixed in 5% or 10% buffered formalin and then preserved in 70% ethanol; some specimens were treated with 2% KOH before dissection.

Drawings and measurements were made with the aid of a camera lucida and ocular micrometer. Carapace lengths (=CL) of the zoeal stages were measured from the anterior border of the eye-stalks to the midline posterior edge of the carapace; rostral spine lengths (=RSL) from the tip of the rostrum to the anterior border of the eyestalks; total carapace lengths (=TCL) from the tip of the rostral spine to the midline posterior edge of the carapace. For the megalopa, CL and carapace width (=CW) were measured at their greatest distances across the carapace. The numbering of the telsonal processes follows Pike & Williamson (1960), and all series of setal armature were listed from proximal to distal.

Description of the Larvae

1. Prezoea.

Following the method by Rice (1981), prezoeas were obtained by dissecting fixed specimens of eggs, just before hatching. The body is covered with a thin embryonic cuticle. Antennule (Fig. 2A) and antenna (Fig. 2B) with 2 and 4 plumose cuticular processes, respectively. Cuticular processes also occur on the telson (Fig. 2C); the latter shows a median indentation, but detailed shape and armatures were unclear.

2. First zoea.

Duration: 9–10 days.

Dimensions: TCL=3.1–3.6 mm (mean 3.3 mm; 5 specimens); CL=1.5–1.8 mm (mean 1.6 mm); RSL=1.5–1.9 mm (mean 1.7 mm).

Carapace (Fig. 3A): Smooth, slightly flattened laterally, with a long rostral spine; eyes sessile.

Abdomen (Fig. 3A, 4I): 5 slender somites plus a bifurcated telson; somites 3–5 with posterolateral spines; elongate telson with 7 posterior processes on each furca; process 1 (outermost) longest and smooth, and reduced hair-like process 2 ventrally situated near the base of process 3 (Fig. 4I′); processes 3–7 armed with spinules.

Antennule (Fig. 4A): Uniramous and unsegmented protopod with 3 long aesthetascs and 2 setae terminally; a short seta near the base. *Antenna* (Fig. 4B): Biramous protopod with a distal stout spine; endopod bud small, about 0.2 times as long as exopod length; exopod tapering distally, bearing 4 serrated setae. *Mandible* (Fig. 4C): Incisor process flattened and large; molar process small. *Maxillule* (Fig. 4D): Coxal endite with 9 setae; basal endite with 3 stout cuspidate spines and a short seta; endopod unsegmented with 3 distal setae and a minute proximal seta. *Maxilla* (Fig. 4E): Coxal endite with 6 setae on its proximal lobe, 3–4 setae on distal lobes; basal endite with 5–6 and 5 setae on each lobe; endopod unsegmented bearing 4 terminal and one subterminal setae; scaphognathite with 19 soft plumose setae around anterior lobe, posterior lobe naked. *Maxilliped* 1 (Fig. 4F): Coxa with one minute seta; basis with ventral setae arranged 1+3+2+3; endopod 4-segmented with 3, 2, 1+2, 4 ventral setae, and each segment also bearing a dorsal

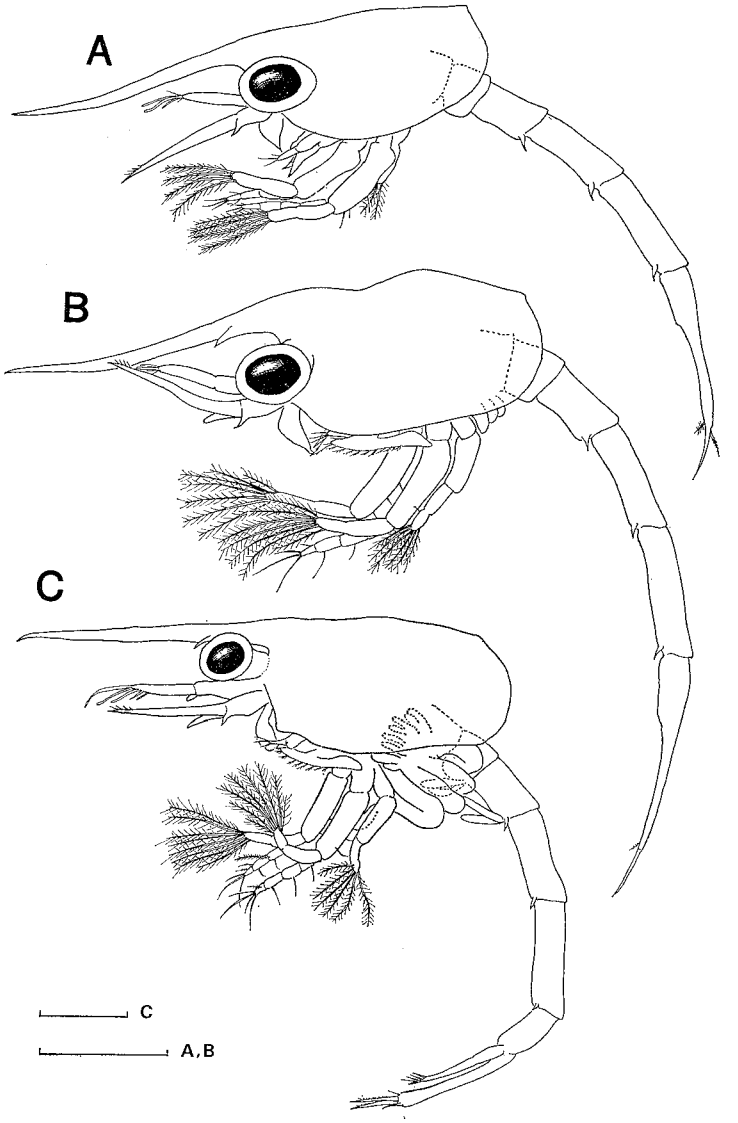

Fig. 3. *Lophomastix japonica* (Duruflé), zoeal stages in lateral view: A, first zoea; B, second zoea; C, third zoea. Scale bars 1.0 mm.

plumose seta (=I); exopod 2-segmented with 4 long natatory setae distally. *Maxilliped* 2 (Fig. 4G): Coxa without setae; basis with 1+2 ventral setae; 4-segmented endopod with 3, 2, 1+2, 4+I setae (I=dorsal plumose seta); exopod as in maxilliped 1. *Maxilliped* 3 (Fig. 4H): Coxa and basis naked; exopod with 2 long plumose setae.

Pereiopods: Small and unsegmented buds.

3. Second zoea.

Duration: 6–7 days.

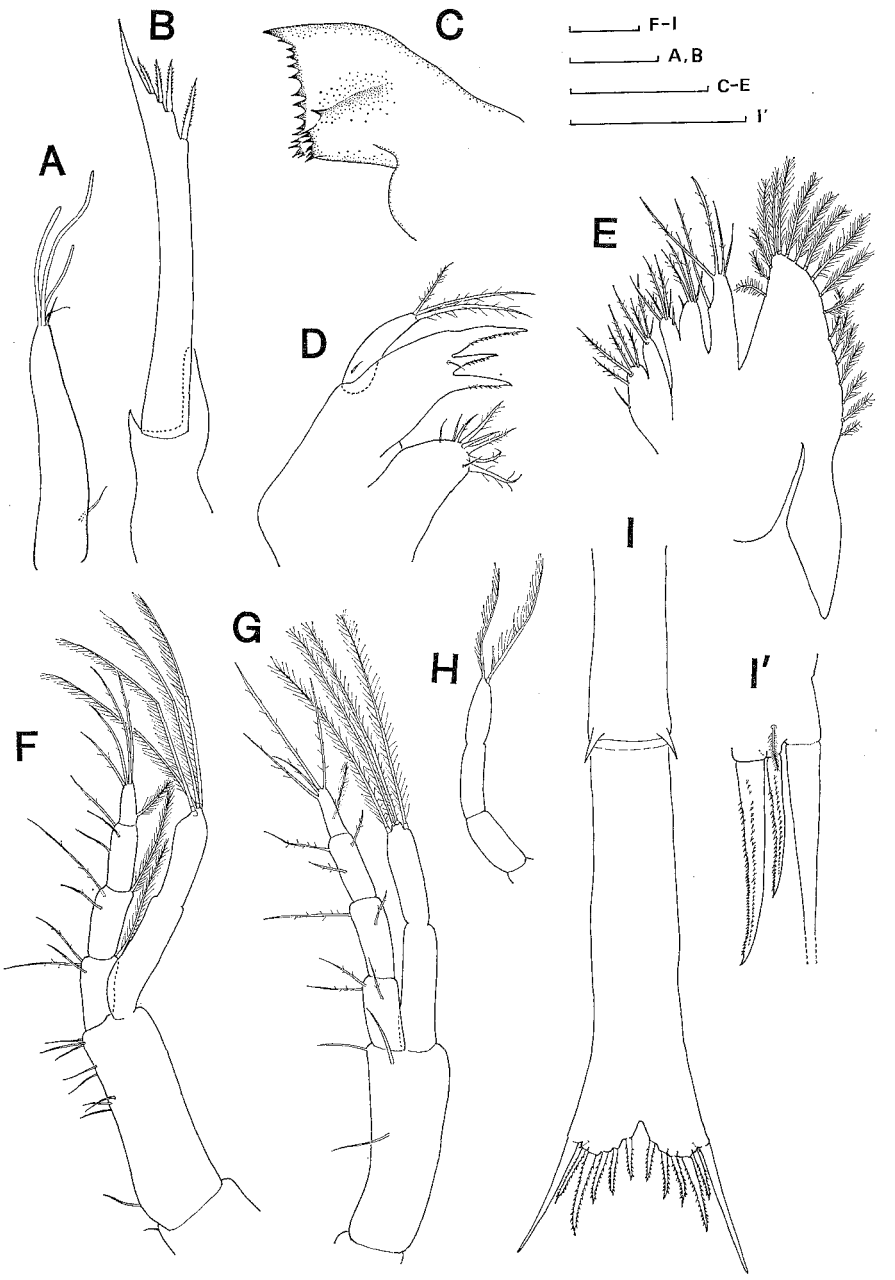

Fig. 4. *Lophomastix japonica* (Duruflé), first zoea: A, antennule; B, antenna; C, mandible; D, maxillule; E, maxilla; F, maxilliped 1; G, maxilliped 2; H, telson; H′, telsonal furca in high magnification. Scale bars 0.2 mm.

Dimensions: TCL=4.1–4.3 mm (mean 4.2 mm; 7 specimens); CL=1.8–2.2 mm (mean 2.1 mm); RSL=2.0–2.3 mm (mean 2.2 mm).

Carapace (Fig. 3B): Rostral spine with a pair of short anterior-directed spines near the base; eye movable.

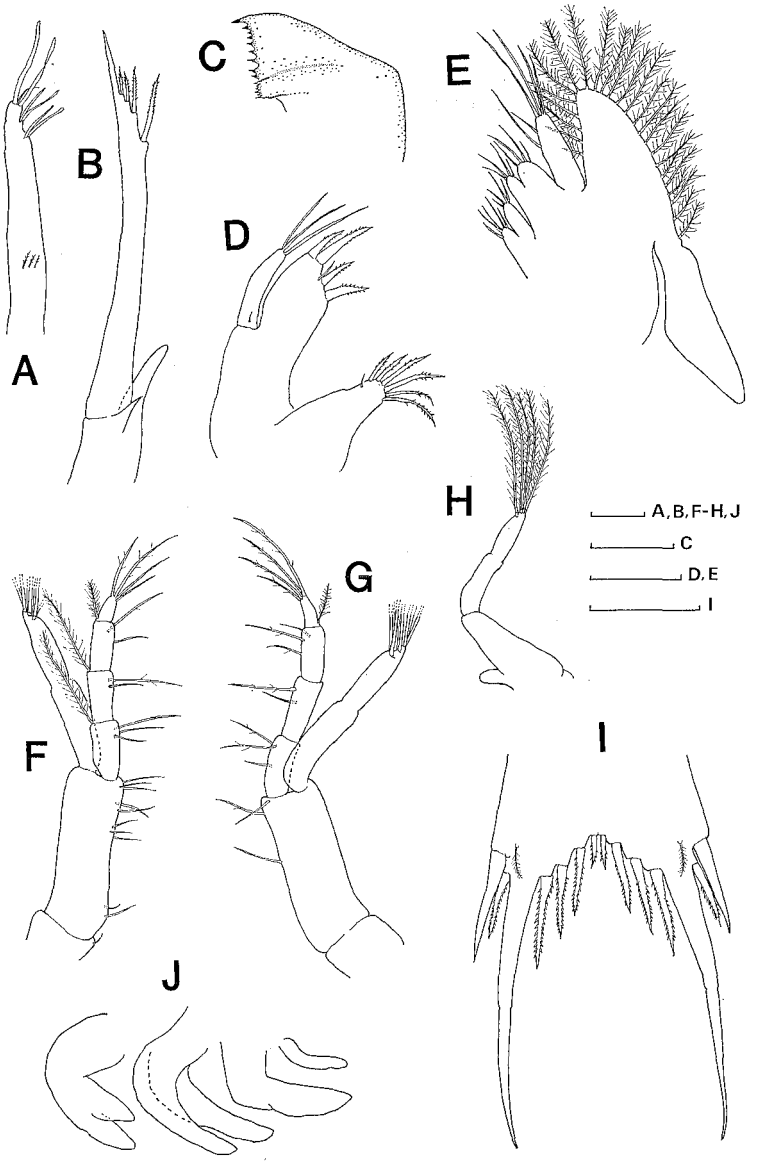

Fig. 5. *Lophomastix japonica* (Duruflé), second zoea: A, antennule; B, antenna; C, mandible; D, maxillule; E, maxilla; F, maxilliped 1; G, maxilliped 2; H, maxilliped 3; I, telson; J, pereiopods. Scale bars 0.2 mm.

Abdomen (Fig. 5I): Telsonal process 4 larger than adjacent articulated processes; process 8 now present.

Antennule (Fig. 5A): 2 apical, 2 subapical and 2 lateral aesthetascs; one seta terminally; 3 fine setae at the middle portion. *Antenna* (Fig. 5B): Endopod elongated, now 0.33 times as long as exopod length. *Mandible* (Fig. 5C): Relatively unchanged from zoea 1; more numerous teeth. *Maxillule* (Fig. 5D): Coxal endite

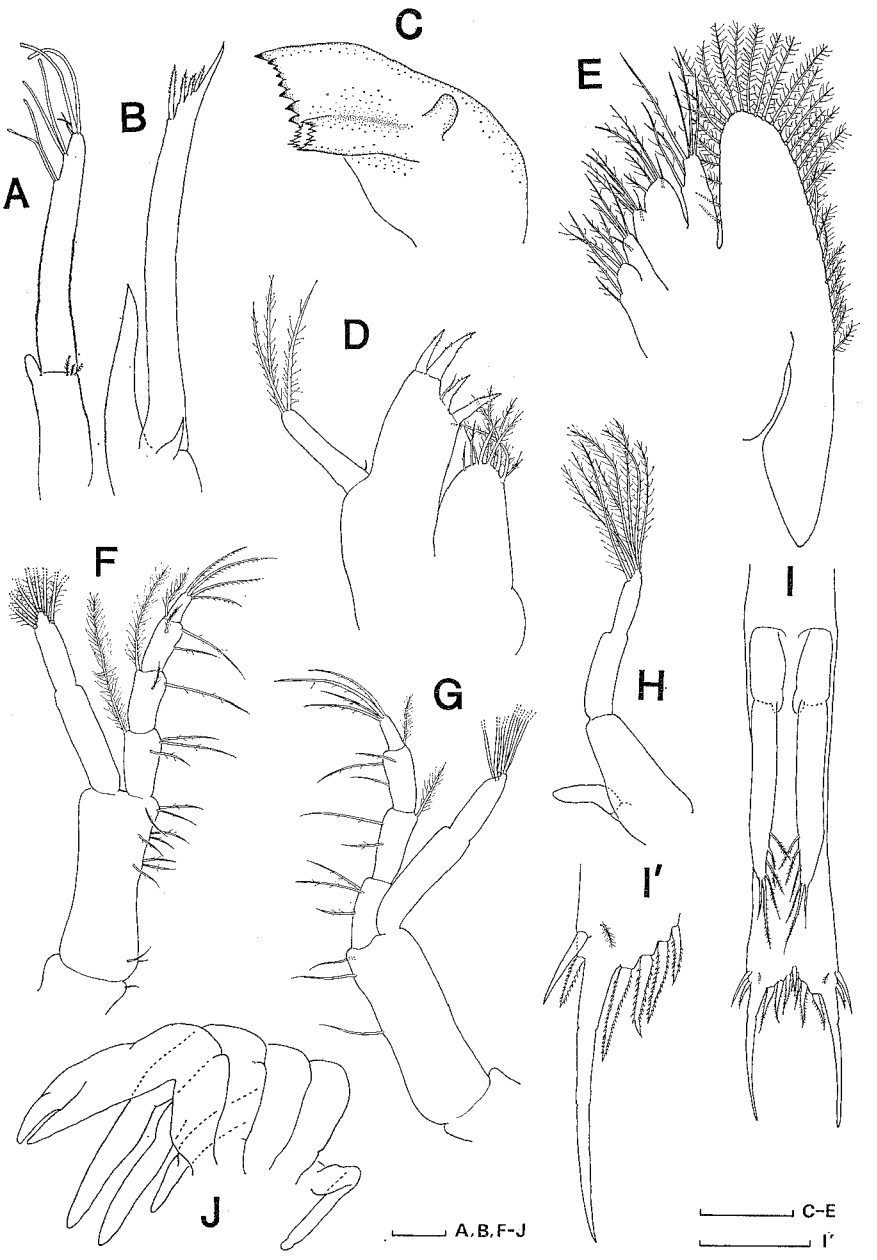

Fig. 6. *Lophomastix japonica* (Duruflé), third zoea: A, antennule; B, antenna; C, mandible; D, maxillule; E, maxilla; F, maxilliped 1; G, maxilliped 2; H, maxilliped 3; I, telson; I′, telsonal furca in high magnification; J, pereiopods. Scale bars 0.2 mm.

with 7 setae; basal endite with 4 stout cuspidate spines and one seta; endopod unchanged. *Maxilla* (Fig. 5E): Coxal and basal endites with fewer setae, now 5,4 and 4,3, respectively; endopod adds one more lateral seta; scaphognathite bearing

23–25 soft plumose setae. *Maxilliped* 1 (Fig. 5F): Endopod setae unchanged; exopod with 7 natatory setae. *Maxilliped* 2 (Fig. 5G): Exopod as in maxilliped 1; otherwise unchanged. *Maxilliped* 3 (Fig. 5H): Endopod setae unchanged; exopod with 5 plumose setae.

Pereiopods (Fig. 5J): Bud of pereiopod 1 (cheliped) biramous.

4. Third zoea.

Duration: 8–9 days.

Dimensions: TCL=5.4–5.9 mm (mean 5.6 mm; 4 specimens); CL=2.7–2.9 mm (mean 2.7 mm); RSL=2.6–3.1 mm (mean 2.9 mm).

Carapace (Fig. 3C): Similar to the previous stage, but the eyes relatively small to the carapace than in the previous stages.

Abdomen (Fig. 6I): Somites 2–3 with pleopod buds; telson with a pair of 2-segmented uropods proximally (somite 6 indistinctly differentiated); uropod with endopod bud; distal portion of uropodal exopod bearing 6 setae; telsonal process 1 shorter than in the previous stage (Fig. 6I').

Antennule (Fig. 6A): Two-segmented; proximal segment with endopod bud and 3 fine setae distally; arrangement of aesthetascs of distal segment as in the zoea 2, but 2 setae terminally. *Antenna* (Fig. 6B): Endopod elongated, now about 0.4 times as long as exopod length; otherwise unchanged. *Mandible* (Fig. 6C): Bud of palp present. *Maxillule* (Fig. 6D): Coxal endite with 10 setae. *Maxilla* (Fig. 6E): Coxal and basal endites with 6,4 and 5,5 processes respectively; endopod bearing 2+4 setae; scaphognathite with 34–36 soft plumose setae. *Maxilliped* 1 (Fig. 6F): Exopod with 8 natatory setae. *Maxilliped* 2 (Fig. 6G): Endopod setal formula 1+2, 2+I, 1+2+I, 4+I; exopod as in the maxilliped 1. *Maxilliped* 3 (Fig. 6H): Endopod bud elongated; exopod with 8 plumose setae.

Pereiopods (Fig. 6J): Longer than previous stage; indistinctly segmented.

5. Megalopa.

Duration: undetermined.

Dimensions: CL=3.3–3.4 mm; CW=2.1–2.3 mm.

Carapace (Fig. 7A, 7B): Subovate, resembling adult form, with one prominent and 2 small anterolateral teeth, but the medial small teeth occasionally indistinct; rostrum extending beyond the peduncle of antenna; lateral margin armed with several teeth and numerous plumose setae; posterior margin deeply concave.

Abdomen (Fig. 7A, 7C): 6 somites and a telson; somites 2–4 bearing lateral triangular process; the second and third somites with a pair of pleopods; telson an oval plate with a postero-lateral constriction, armed with 30–32 long marginal setae.

Antennule (Fig. 7A, 8A): Peduncle 3-segmented, bearing many plumose setae on each segment; ventral flagellum 3-segmented with 2 setae on the penultimate and ultimate segments; dorsal flagellum consisting of 23–25 segments, bearing 1–2 aesthetasc(s) plus 1–3 seta(e) on 5 distalmost segments. *Antenna* (Fig. 8B): Peduncle 3-segmented with a lateral irregularly-shaped setose scaphocerite; flagellum 10-seg-

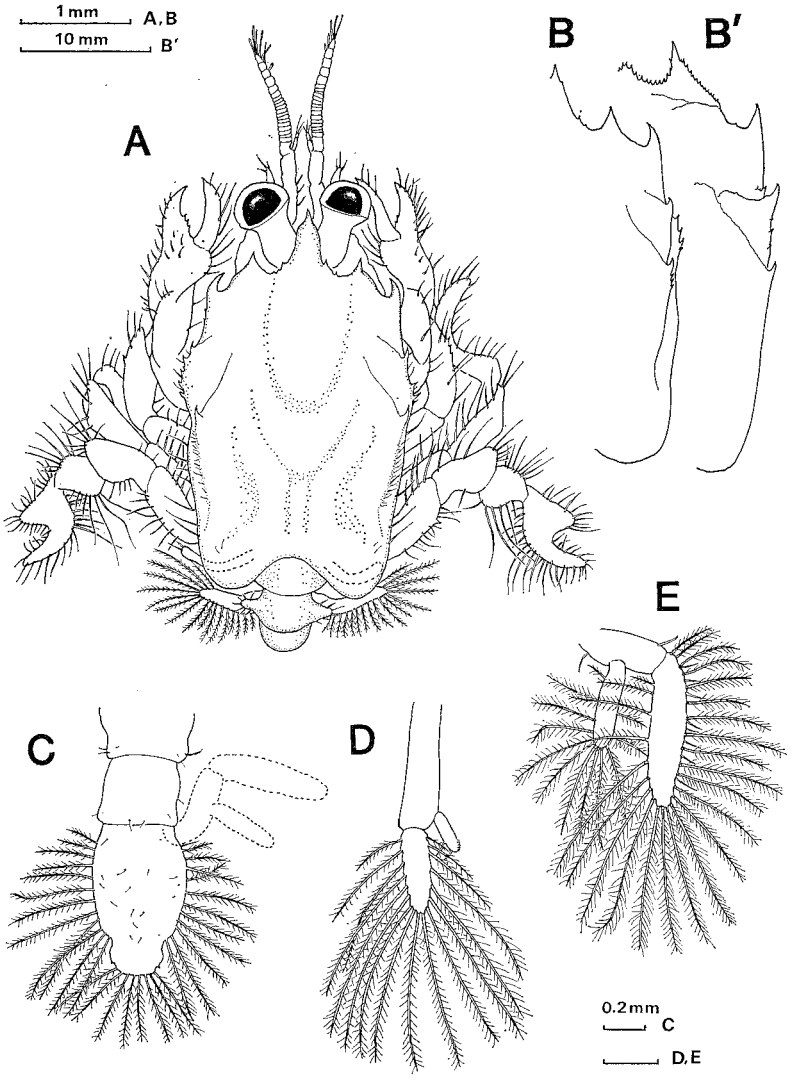

Fig. 7. *Lophomastix japonica* (Duruflé), megalopa: A, dorsal view; B, right half of carapace outline comparing that of adult crab (B′); C, telson; D, pleopod on somite 2; E, uropod. Scale bars 1.0 mm for A–B, 10.0 mm for B′, and 0.2 mm for C–E.

mented. *Mandible* (Fig. 8C): Scoop-shaped process; palp 3-segmented, with a seta on the proximal, and 4 plumose setae on the penultimate segment; ultimate naked. *Maxillule* (Fig. 8D): Coxal endite with 9–10 simple setae; basal endite with 5 stout spines, 2 spinules and 2 setae; endopod inflated, with an anterior spine and a posterior plumose seta. *Maxilla* (Fig. 8E, 8E′): Coxal endite with 15–16 and 4–5 setae on proximal and distal lobe, respectively; basal endite with 4 setae on proximal, and 5–7 setae on distal segment; endopod bearing 2 long inner setae, one short terminal seta and 4–5 proximal plumose setae; scaphognathite with 145–157 soft plumose

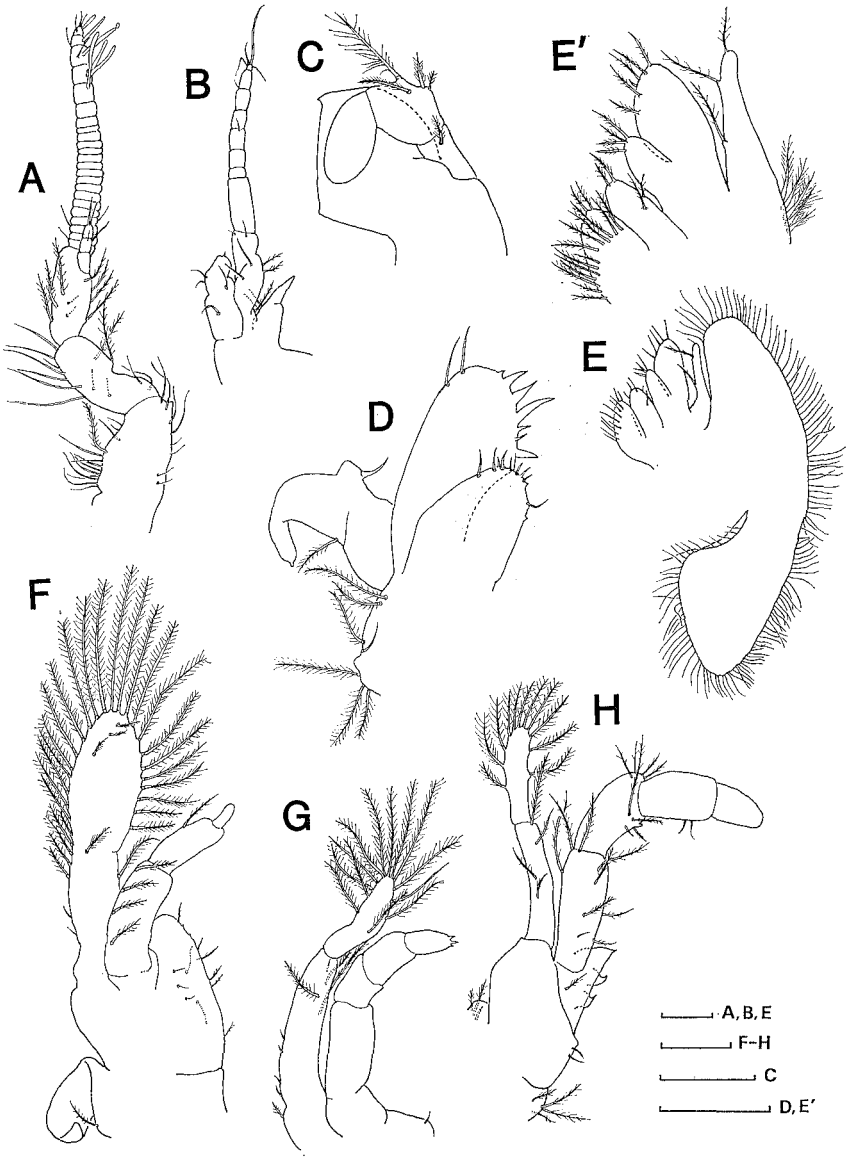

Fig. 8. *Lophomastix japonica* (Duruflé), megalopa: A, antennule; B, antenna; C, mandible; D, maxillule; E, maxilla; E′, endites and endopod of maxilla; F, maxilliped 1; G, maxilliped 2; H, maxilliped 3. Scale bars 0.2 mm.

setae. *Maxilliped* 1 (Fig. 8F): Coxa with an inflated epipod; basis bearing 10–11 inner setae; endopod 4-segmented with 4 setae on the second and one seta on the penultimate segment; paddle-like exopod larger than endopod, 2-segmented, with 27 long marginal plumose setae. *Maxilliped* 2 (Fig. 8G): Coxa and basis with one short seta; endopod 5-segmented, distal segment armed with 3 spinules; exopod incompletely 2-segmented with 13–15 long marginal plumose setae, and the proximal

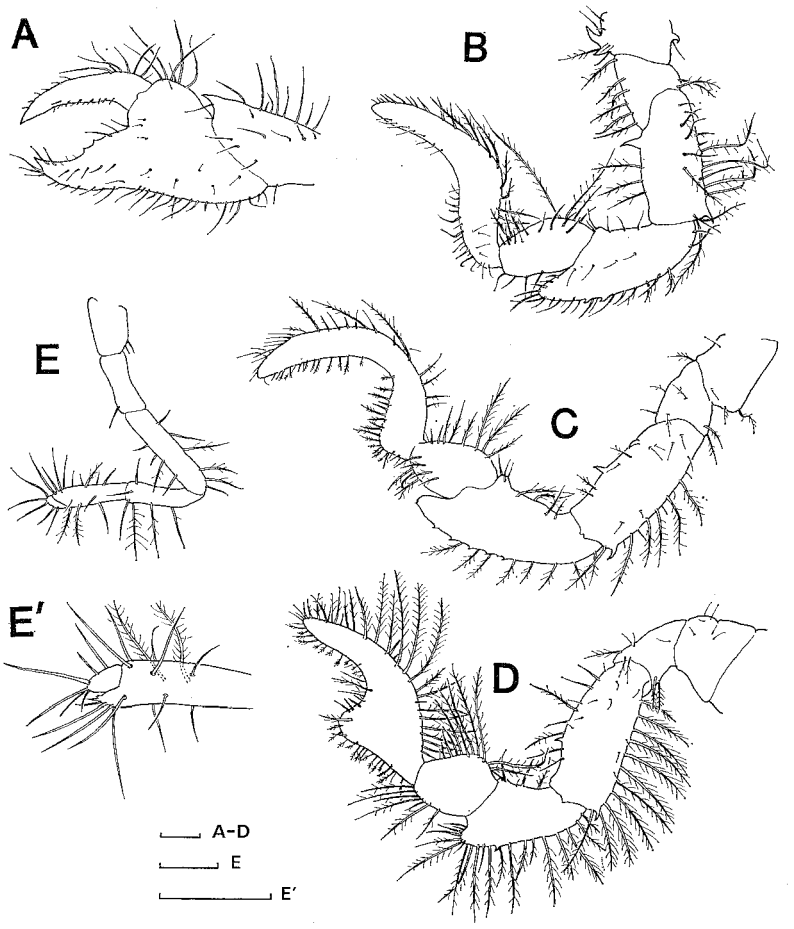

Fig. 9. *Lophomastix japonica* (Duruflé), megalopa: A, pereiopod 1 (cheliped); B, pereiopod 2; C, pereiopod 3; D, pereiopod 4; E, pereiopod 5; E′, dactylus of pereiopod 5. Scale bars 0.2 mm.

segment with 5–6 long plumose setae plus 4 short setae. *Maxilliped* 3 (Fig. 8H): Coxa and basis with 9 and 2 setae, respectively; endopod 5-segmented, and inner side of the proximal segment armed with 3 stout spines and a seta; exopod 2-segmented with 4 long plumose setae on the proximal and 11 on the distal segment.

Pereiopod 1 (Fig. 9A): Chelate as in adult form, but dactylus not much smaller than propodus; all segments bearing numerous plumose setae, as do the remaining pereiopods. *Pereiopods* 2–3 (Fig. 9B, 9C): Dactylus inflated, sickle-shaped as illustrated. *Pereiopod* 4 (Fig. 9D): Similar to pereiopods 2–3, but dactylus with an inner triangular projection. *Pereiopod* 5 (Fig. 9E, 9E′): Short, slender, and cylindrical in comparison to other pereiopods; distal segment chelate, bearing 2 plumose and 19 simple setae (Fig. 9E′).

Pleopods (Fig. 7D): Biramous; endopod armed with 5 inner hooklets and 1–2 simple setae; exopod fringed with 17–19 long plumose setae.

Uropod (Fig. 7E): Biramous, located on the sixth abdominal somite; basis with 2 setae; endopod smaller than exopod, bearing 11 long plumose setae; exopod with 23–25 long plumose and 8 short simple setae interspersed between.

Discussion

Comparison of albuneid zoeas.

The family Albuneidae consists of eight genera (Efford & Haig, 1968) and larval stages have been known in four genera. Since Menon (1937) described planktonic larvae of *Albunea symnista*, larval studies have been done in two *Albunea* species (Gurney, 1942), in four *Blepharipoda* species (Johnson & Lewis, 1942; Kurata, 1965; Knight, 1968; Boschi *et al.*, 1968), in five *Lepidopa* species (Johnson & Lewis, 1942; Knight, 1970; Kurata, 1970; Sandifer & Van Engel, 1972; Sánchez & Anguilar, 1975; Gore & Van Dover, 1980; Stuck & Truesdale, 1986), and in one *Lophomastix* species (Kurata, 1965). Most previous studies on albuneid larvae were based on planktonic materials. No complete larval stages from a known parental female have been described in the genus *Lophomastix* (see Table 1). At present, only Kurata's

Table 1. Larval descriptions in the family Albuneidae

Species	Stage(s)	Source of material	Author(s)
Albunea			
symnista	Z1-5	P	Menon, 1937
sp.	Z1	P	Gurney, 1942
Blepharipoda			
occidentalis	Z1, LZ	P + L	Johnson & Lewis, 1942
occidentalis	Z1-5, M	L	Knight, 1968
spinimana	Z1-4	P	Knight, 1968
doelloi	Z1-5, M	L	Boschi *et al.*, 1968
liberata	Z1-2	P	Kurata, 1965
Lepidopa			
benedicti	Z1-4, M, C1-4	L	Stuck & Truesdale, 1986
californica[1)]	Z1	L	Johnson & Lewis, 1942
californica[1)]	Z1-5, M	L	Knight, 1970
chilensis	Z1-5, M	L	Sánchez & Anguilar, 1975
richmondi	Z1-3, M	P + L	Gore & Van Dover, 1981
websteri	LZ, M	P + L	Kurata, 1970
websteri	Z1-3	P	Sandifer & Van Engel, 1972
Lophomastix			
japonica[2)]	Z1-2, 5	P	Kurata, 1965
japonica	Z1-3, M	L	present study

C: crab stage, L: laboratory-reared, M: megalopa, P: plankton,
Z: zoea, LZ: later zoea.
1) as *L. myops*
2) as *Blepharipoda fauriana*

Table 2. Comparison of selected larval characters between zoeas of *Blepharipoda* and *Lophomastix*.

	Blepharipoda					*Lophomastix*	
	occidentalis (Johnson & Lewis, 1942)	*occidentalis* (Knight, 1968)	*spinimana* (Knight, 1968)	*doelloi* (Boschi *et al.*, 1968)	"*liberata*" (Kurata, 1965)	"*japonica*" (Kurata, 1965)	*japonica* (this study)
Zoeal instar	ND	5	ND	5	ND	5	3
Carapace: RSL/CL (Z1)	1.92	2.41	2.41	2.00	1.02	2.00	1.04
Maxillule: endopod	3	1+3	1+3	3	3	3	1+3
Maxilla: endopod	4	4	4	4	1+4	4	1+4
Maxilliped 1: basis	2	1+2	1+3	1+2	ND	ND	1+2
Maxilliped 2: basis	ND	1+2+3+3	1+2+3+3	1+2+3+3	ND	ND	1+2+3+3
endopod	ND	3, 2, 3, 4+I	3+1, 2+1, 3, 4+I	3+1, 2+1, 3+1, 4+I	ND	ND	3+1, 2+1, 3+1, 4+I
Abdomen: pleopod (LZ)	somites 2-4	somites 2-4	somites 2-4	(somites 3-4)*	ND	somites 2-4	somites 2-3
segmentation of somite 6	ND	−	−	(−)**	ND	+	−
Telson: MP (LZ)	+	+	+	(−)**	−	+	−

I: dorsal plumose seta, CL: carapace length, LZ: later zoea, MP: median process, ND: no data, RSL: rostral spine length, +: present, −: absent.

* they showed pleopod buds on somites 3-4 in last zoea and on somites 2-5 in megalopa.

** some inconsistencies exist between the descriptions and the illustration.

(1965) zoeal description of *L. japonica* (as *Blepharipoda fauriana* Bouvier) is available for comparison of albuneid larvae in the genus *Lophomastix*.

Table 2 lists selected larval characters of known zoeas of *Blepharipoda* and *Lophomastix*. The larval characters of the zoeas of *Lophomastix japonica* reconstructed from planktonic specimens by Kurata (1965) are remarkably different from those in this study obtained from laboratory-hatched material, particularly in the RSL/CL ratio, maxillary endopod setation, median telsonal process in late zoeas, and number of zoeal instars. The RSL/CL ratio of *Blepharipoda* zoeas usually exceeds 2.00 except in Kurata's *B. liberata*, while it is just 2.00 in his *L. japonica*. On the other hand, the ratio of the present material is approximately equal to that of *B. liberata* noted by Kurata. The setation of the endopod of maxilla is 4 in Kurata's specimens, while 1+4 in the present material. The median posterior process of telson is found in the zoeas 2 and 5 by Kurata, but the zoeas in the present study lack the process throughout zoeal stages. In this study, *Lophomastix japonica* passed through three zoeal stages while Kurata (1965) reported five for the same species. As found in *Lepidopa* species, the number of zoeal instars in albuneids is variable, from three to five. In general, the number of zoeal instars in decapod crustaceans is thought to be specific for each species. Concerning instar number of zoeas, many larval studies have shown that the number is occasionally variable within a species; e.g., Knight (1968) stated that the number of zoeal stages in the larval development of *B. occidentalis* in the laboratory was variable with either five or six moults before metamorphosis to megalopa. However she examined plankton materials and pointed out that five zoeal stages were regular in natural conditions. At present three zoeal stages seem to be normal in the development of *L. japonica*, although the possibility that reduction in instar number is due to artificial conditions cannot be rejected.

The evidence discussed above shows that Kurata's "*Lophomastix*" zoeas closely resemble those of *Blepharipoda* rather than *Lophomastix*, as noted by Knight (1968). This suggests that his "*B. liberata*" and "*L. japonica*" should be attributed to *L. japonica* and *B. liberata*, respectively, since at present no other albuneid species have been recorded from Hokkaido. Furthermore, Kurata noted that abdominal somite 6 is recognized in zoea 5 of *B. liberata* (i.e. "*L. japonica*" in his description); in all other studies on *Blepharipoda* larvae, the somite 6 is not differentiated from the telson until megalopal stage. In this respect, the zoeas of *B. liberata* by Kurata are different from those of typical *Blepharipoda* species.

The zoeas of *Blepharipoda* and *Lophomastix* can be distinguished by RSL/CL ratio of carapace, by endopod of maxilla, by median telsonal process after zoea 2 stage, and by somites with pleopod in later zoeal stages: RSL/CL ratio of *Blepharipoda* zoeas usually exceeds 2.00, setation of maxillary endopod is 4, presence of the median telsonal process, and somites 2–4 with pleopods.

A tentative key to identification of Japanese albuneid zoeas is given below:

A. Carapace with posterior spines; telson ovoid, bearing numerous posterior processes ..... *Albunea*

– Carapace without posterior spines; telson slender, bearing 7 posterior processes ..... B

B. Maxillary endopod setation 4; telson of later zoea bearing a median posterior process; last zoea with pleopods on abdominal somites 2–4 ..... *Blepharipoda*

– Maxillary endopod setation 1+4; telson of later zoea lacking median posterior process; last zoea with pleopods on abdominal somites 2–3 ..... *Lophomastix*

Table 3 compares general larval features of the family Albuneidae, using 13 selected characters. Among four albuneid genera, zoeas of *Blepharipoda* and *Lophomastix* are quite similar, except for somites with pleopod in later zoeal stage. On the other hand, the zoeas of these two genera are different from those of *Albunea* and *Lepidopa* in 9–12 characters. Six larval characters of *Albunea* accord with those of *Lepidopa*. Thus three larval groups, i.e. *Albunea, Lepidopa* and *Blepharipoda*+*Lophomastix,* can be recognized in albuneid zoeas. This fact generally corresponds to the groupings of adult albuneid crabs proposed by Efford (1969), in which this family is divided into three groups: *Albunea*-group, *Lepidopa*-group and *Blepharipoda*-group. He regarded the *Blepharipoda*-group, consisting of *Blepharipoda* and *Lophomastix*, as a rather separate off-shoot from the ancestral albuneid form. However, larval evi-

Table 3. Comparison of general larval characters in four albuneid genera.

Character	*Albunea*	*Lepidopa*	*Blepharipoda*	*Lophomastix*
Carapace:				
length	short	long	long	long
rostral spine	+	+	+	+
posterior spine	+	+	–	–
Antenna (Z1);				
exopod (shape)	broad	slender	slender	slender
exopod (setae)	9–10	0–1	4	4
Maxilla:				
endite	1-lobed	2-lobed	2-lobed	2-lobed
Maxilliped 1:				
endopod segments	5	5	4	4
Abdomen:				
lateral spine	—	long	short	short
somite with pleopod (LZ)	somites 2–5	somites 2–5	somites 2–4	somites 2–3
segmentation of somite 6	zoea 4	zoea 3	—	—
Telson:				
shape	semicircular	triangular	slender	slender
posterior processes	numerous	numerous	7	7
process 4	long	long	long	short

LZ: later zoea, +: present, –: absent.

dences do not necessarily support Efford's scheme for the phylogenetic relationships among these groups; for example, the zoeal character of the *Blepharipoda*-group is apomorphic in having fewer segments in maxilliped 1, whereas that of the *Albunea*-group is regarded as plesiomorphic.

Morphological notes on megalopal stage.

Megalopa stages of albuneid crabs are now known in three genera: *Lepidopa, Blepharipoda* and *Lophomastix*. In general, the shape of the albuneid megalopas closely resembles the adult crab form. Using adult characters, Gore & Van Dover (1980) identified a single megalopa specimen, which was obtained by laboratory-rearing of planktonic zoea, as *Lepidopa richmondi* Benedict. In contrast, based on a series of complete laboratory-cultured materials of larvae and juvenile crabs of *L. benedicti* Schmitt, Stuck & Truesdale (1986) concluded that, at least for these specimens, no adult key characters did appear in the megalopa until crab 4 stage. In the present species the adult diagnostic characters of the genus *Lophomastix* are recognized in the megalopa and include the following: ovoid carapace bearing lateral spines, and endopodal proximal segment of the maxilliped 3 armed with strong teeth. These features easily distinguish this megalopa from those of *Lepidopa*. Also in the present study, three pairs of anterolateral teeth on the carapace are found at this stage (see Figs 7B and 7B'). Adult crabs of both *Blepharipoda* and *Lophomastix* bear four and three spiniform anterolateral teeth, respectively (Efford & Haig, 1968; Miyake, 1978, 1982). Knight (1968) stated that the carapace of the megalopa of *B. occidentalis* closely resembles that of adult crabs, having four anterolateral spines. Stout teeth on endopod of maxilliped 3 are also found in the megalopa of *B. occidentalis*. Thus the megalopas of three albuneid genera are different from each other in 2 adult characters.

In addition, megalopas of these three albuneid genera are different in the number of paired pleopods. For example, in the megalopal stage, *Lepidopa, Blepharipoda* and *Lophomastix* bear pleopods on somites 2–5, 2–4 and 2–3, respectively. In this respect, Boschi *et al.* (1968) stated that in *B. doelloi* the abdomen of the megalopa had biramous pleopods on somite 2–5. In their description, however, inconsistency exists, because they also stated in the same text that exopod of the pleopod on somites 1(?), 2, and 3 bore 18, 12, and 11 setae, but they figured such setation in pleopods on somites 2–4. They gave no description of pleopods on somite 5. Thus the location of pleopods on somites 2–4 is thought to be normal in *Blepharipoda* megalopas.

In conclusion, the megalopas of at least three genera, *Lepidopa, Blepharipoda* and *Lophomastix,* are distinguishable from each other, using two adult and one larval diagnostic characters. At present, however, identification to species in each genus remains uncertain.

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